

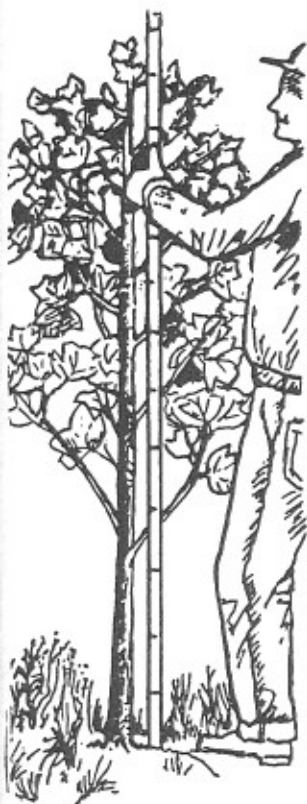
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LOBLOLLY PINE RELEASE STUDY

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LOBLOLLY PINE RELEASE

Report #21

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ABSTRACT

This study included three treatments in which basal spraying, using two different concentrations of 2,4,5-T, was compared to no release. Basal spraying was done in the winter, following the first growing season in the field. Hardwood competition was moderate to severe. At age 17, 1:40 plots averaged 29 percent more basal area and 66 percent more volume in standard cords than check plots, and 1:20 plots averaged 28 percent more basal area and 48 percent more volume in standard cords than check plots. Cordwood yields were related to both a free-to-grow index estimated at age 2 ($r^2 = .672$) and hardwood basal area measured at age 17 ($r^2 = .523$).

INTRODUCTION

This is the twenty-first in a series of Occasional Reports concerning release of loblolly pine seedlings from hardwood competition. This study was installed on the privately-owned Carter tract in Campbell County, in the south-central Piedmont of Virginia. The previous stand was hardwood, predominantly oak. Site preparation was by drum-chopping and prescribed-burning in the summer of 1970, followed by planting in March of 1971. Basal spraying was done on March 1 and 2, 1972, after the first growing season in the field. Three swaths, each two chains wide and 10 chains long, were established (Figure 1). One swath was basal sprayed using a 1:40 dilution of 2,4,5-T in fuel oil and another swath was basal sprayed using a 1:20 dilution, leaving the third swath unsprayed as a control. The 2,4,5-T contained four pounds of active ingredient per gallon.

The remainder of the tract, surrounding the study area on three sides, was aerially released about four years after the seedlings were planted. The pilot was instructed to avoid the study area, but some "drift" damage occurred over the entire study area. The damage was not severe, but leaders were killed back on practically all hardwood species. This damage was still quite noticeable when the plots were remeasured at age 10. The check plots probably benefited more than the basal sprayed plots, so that the yield differences reported here are probably somewhat conservative.

GROWTH PLOT INSTALLATION

Plots were installed in February of 1973, two years after planting and one year after basal spraying. Nine 1/10-acre plots were installed, three in each swath. Plots were crowded to the front of the swaths to avoid the steeper slopes along a draw originating in the 1:20 swath (Figure 1). Hardwood competition was moderate to severe, with red oak the most abundant hardwood species, followed by white oak. Volunteer Virginia pine and short-leaf pine seedlings were pulled up when the plots were installed.

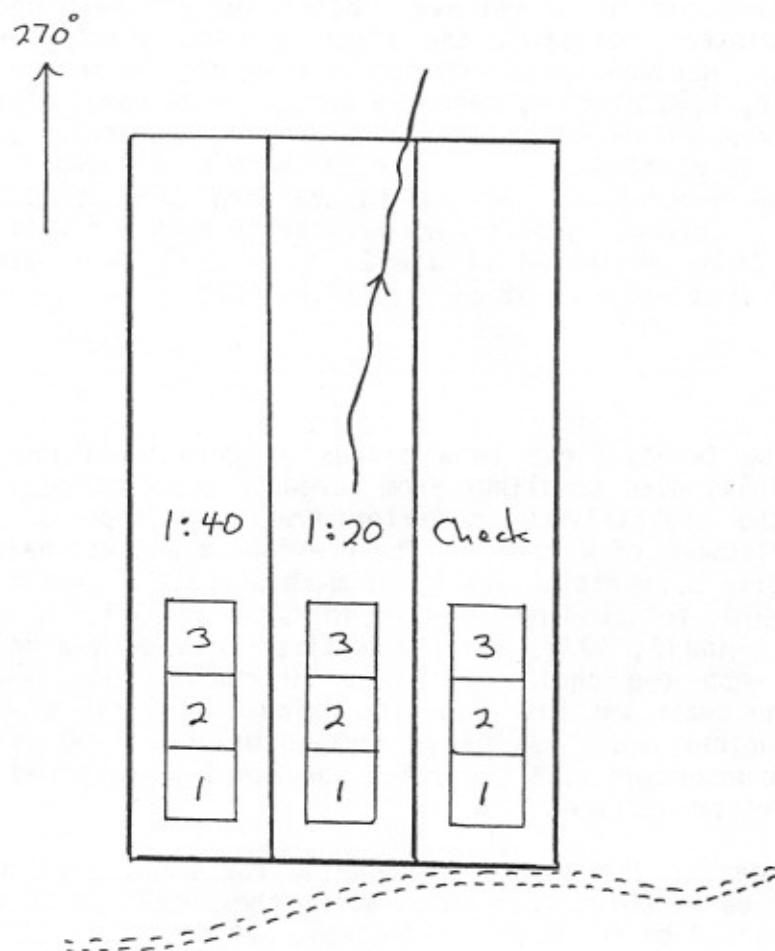


Figure 1. Layout of growth plots.

Measurements were made at age 2, when the plots were established, and at ages 9, 13, and 17. At age 2, all loblolly pine seedlings were measured for height to the nearest foot, and classified as to free-to-grow status using a four part classification system.^{1/} At later measurements, diameter at breast height of each loblolly pine was measured to the nearest inch, and a sample of trees in each diameter class was measured for total height to the nearest foot, noting which trees were dominant or codominant. For the final measurement at age 17, all hardwoods over .5 inch DBH were tallied by species, 1-inch diameter class, and crown class. Total height to the nearest foot was measured on 90 percent of the intermediate hardwoods and all of the codominant hardwoods (there were no dominant hardwoods).

RESULTS AND DISCUSSION

A summary of loblolly pine data for the four measurements is presented in Table 1. At age 17, 1:40 plots averaged 8.2 standard cords per acre and 1:20 plots averaged 6.0 standard cords per acre more than check plots.^{2/} Differences due to release increased with time (Table 2). Table 3 presents stand tables for loblolly pine at age 17.

A summary of average hardwood data at the final measurement at age 17 is presented in Tables 4 and 5, and individual plot data is presented in Table 6. Comparing average numbers of hardwoods, 1:40 plots had almost as many hardwoods as check plots and 1:20 plots had about 10 percent fewer hardwoods than check plots. Hardwoods were somewhat larger, however, on the check plots, resulting in greater hardwood basal area on the check plots. On the average, check plots had 28 percent more hardwood basal area than 1:40 plots and 60 percent more hardwood basal area than 1:20 plots. There were only two codominant hardwoods on all nine plots, both on 1:40 plot 1. These codominants were both yellow-poplar, and their heights were 41 and 43 feet. All plots will end up eventually with pure loblolly pine in the canopy.

Cordwood yields of loblolly pine at age 17 were related to the amount of hardwood present. Figure 2 shows pine cordwood yields related to hardwood basal area at age 17, for the nine plots. A simple linear regression fitted to these data accounted for 52 percent of the variation in cordwood yields.^{3/}

- 1/ See Occasional Report No. 78 (Release Report No. 11) for a description and discussion of this classification system.
- 2/ Standard cords at age 17 were subjected to an analysis of variance for randomized blocks (caution should be used in interpreting the results of this analysis, because treatment plots could not be truly randomized). The probability of a larger overall F for treatments was .0038. Duncan's New Multiple Range Test was used to test for differences between treatment means. Average yields from both the 1:40 and 1:20 treatments were significantly greater than from the check (.01 level).
- 3/ Estimated standard cords = $30.38 - .6768 (\text{hardwood basal area})$, $r^2 = .523$, probability of a larger F = .028.

Table 1. A summary of loblolly data at ages 2, 9, 13, and 17: number of trees per acre, average DBH, basal area per acre, standard cords per acre, and average height of dominant and codominant trees.*

| Check Plots | | | | | | | 1:40 Plots | | | | | | 1:20 Plots | | | | | |
|-------------|------|-----|------|------|------|------|------------|-----|------|-------|------|------|------------|-----|------|-------|------|------|
| Age | Plot | No. | DBH | B.A. | Cds. | Ht. | Plot | No. | DBH | B.A. | Cds. | Ht. | Plot | No. | DBH | B.A. | Cds. | Ht. |
| 2 | 1 | 600 | - | - | - | 3.5 | 1 | 570 | - | - | - | 3.6 | 1 | 600 | - | - | - | 3.0 |
| | 2 | 560 | - | - | - | 3.4 | 2 | 590 | - | - | - | 3.2 | 2 | 580 | - | - | - | 3.2 |
| | 3 | 560 | - | - | - | 3.5 | 3 | 580 | - | - | - | 3.4 | 3 | 610 | - | - | - | 3.0 |
| Means | | 573 | - | - | - | 3.5 | 580 | | - | - | - | 3.4 | 597 | | - | - | - | 3.1 |
| | | | | | | | | | | | | | | | | | | |
| 9 | 1 | 570 | 3.46 | 39.4 | - | 23.3 | 1 | 570 | 4.35 | 63.0 | - | 25.2 | 1 | 570 | 3.95 | 50.8 | - | 23.9 |
| | 2 | 530 | 3.36 | 34.2 | - | 20.9 | 2 | 590 | 3.97 | 54.3 | - | 25.3 | 2 | 580 | 4.00 | 53.1 | - | 23.7 |
| | 3 | 560 | 3.36 | 37.8 | - | 21.3 | 3 | 580 | 3.88 | 49.9 | - | 23.1 | 3 | 610 | 3.67 | 47.1 | - | 21.3 |
| Means | | 553 | 3.39 | 37.1 | - | 21.8 | 580 | | 4.07 | 55.7 | - | 24.5 | 587 | | 3.87 | 50.3 | - | 23.0 |
| | | | | | | | | | | | | | | | | | | |
| 13 | 1 | 560 | 4.79 | 73.5 | 6.1 | 31.9 | 1 | 540 | 5.76 | 102.9 | 13.7 | 36.6 | 1 | 560 | 5.34 | 90.8 | 10.0 | 33.3 |
| | 2 | 530 | 4.75 | 68.4 | 5.6 | 31.2 | 2 | 580 | 5.24 | 91.2 | 10.7 | 37.4 | 2 | 580 | 5.33 | 94.3 | 10.0 | 33.8 |
| | 3 | 540 | 4.76 | 71.6 | 5.9 | 31.8 | 3 | 580 | 5.21 | 89.6 | 9.1 | 32.7 | 3 | 610 | 5.16 | 93.1 | 9.4 | 33.6 |
| Means | | 543 | 4.77 | 71.2 | 5.9 | 31.6 | 567 | | 5.40 | 94.6 | 11.2 | 35.6 | 583 | | 5.28 | 92.7 | 9.8 | 33.6 |
| | | | | | | | | | | | | | | | | | | |
| 17 | 1 | 550 | 5.45 | 95.1 | 12.8 | 39.5 | 1 | 530 | 6.49 | 129.5 | 22.8 | 43.0 | 1 | 560 | 6.00 | 115.4 | 17.6 | 40.0 |
| | 2 | 530 | 5.57 | 94.1 | 12.0 | 36.8 | 2 | 570 | 6.04 | 119.2 | 19.8 | 42.9 | 2 | 560 | 6.25 | 123.4 | 19.2 | 40.6 |
| | 3 | 540 | 5.46 | 94.4 | 12.3 | 38.5 | 3 | 570 | 6.02 | 116.4 | 19.2 | 42.1 | 3 | 600 | 5.97 | 122.9 | 18.4 | 40.4 |
| Means | | 540 | 5.49 | 94.5 | 12.4 | 38.3 | 557 | | 6.18 | 121.7 | 20.6 | 42.7 | 573 | | 6.07 | 120.6 | 18.4 | 40.3 |

*Except at age 2, where heights presented are for all trees.

Table 2. Average differences between check and released plots at each measurement, for basal area and standard cords per acre.

| <u>Age</u> | <u>1:40 minus Check</u> | | <u>1:20 minus Check</u> | |
|------------|-------------------------|------------------|-------------------------|------------------|
| | <u>Basal Area</u> | <u>Std. Cds.</u> | <u>Basal Area</u> | <u>Std. Cds.</u> |
| 9 | 18.6 | - | 13.2 | - |
| 13 | 23.4 | 5.3 | 21.5 | 3.9 |
| 17 | 27.2 | 8.2 | 26.1 | 6.0 |

Table 3. Average number of loblolly pine per acre by diameter class at age 17.

| <u>DBH</u> | <u>Check Plots</u> | <u>1:40 Plots</u> | <u>1:20 Plots</u> |
|------------|------------------------|-----------------------|-----------------------|
| 1 | 3 | 0 | 0 |
| 2 | 13 | 7 | 7 |
| 3 | 20 | 17 | 17 |
| 4 | 90 | 37 | 33 |
| 5 | 120 | 97 | 113 |
| 6 | 167 | 170 | 187 |
| 7 | 97 | 136 | 150 |
| 8 | 30 | 77 | 53 |
| 9 | 0 | 13 | 13 |
| 10 | 0 | 3 | 0 |
| ----- | ----- | ----- | ----- |
| Totals | 540 | 557 | 573 |

Table 4. Average numbers of hardwoods per acre by species and diameter class at age 17.

| <u>Species</u> | <u>Check Plots</u> <u>DBH</u> | | | | | <u>Totals</u> |
|----------------|----------------------------------|----------|----------|----------|----------|---------------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | |
| Red oak | 473 | 136 | 23 | 10 | | 642 |
| White oak | 310 | 220 | 77 | 10 | | 617 |
| Chestnut oak | 10 | | | | | 10 |
| Red maple | 297 | 30 | | | | 327 |
| Blackgum | 153 | | | | | 153 |
| Dogwood | 177 | 7 | | | | 184 |
| Hickory | 90 | 7 | | | | 97 |
| Yellow-poplar | 7 | | | | 3 | 10 |
| Black cherry | 10 | 10 | | | | 20 |
| Totals | 1,527 | 410 | 100 | 20 | 3 | 2,060 |

| <u>Species</u> | <u>1:40 Plots</u> <u>DBH</u> | | | | | | <u>Totals</u> |
|----------------|---------------------------------|----------|----------|----------|----------|----------|---------------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> | |
| Red oak | 677 | 173 | 13 | 10 | | | 873 |
| White oak | 440 | 77 | 10 | | | | 527 |
| Red maple | 180 | 3 | | | | | 183 |
| Blackgum | 43 | | | | | | 43 |
| Dogwood | 147 | 7 | | | | | 154 |
| Hickory | 177 | | | | | | 177 |
| Yellow-poplar | 40 | 7 | | 7 | 3 | 3 | 60 |
| Black cherry | 13 | | 3 | | | | 16 |
| Bigtooth aspen | | 3 | | | | | 3 |
| Totals | 1,717 | 270 | 26 | 17 | 3 | 3 | 2,036 |

| <u>Species</u> | <u>1:20 Plots</u> <u>DBH</u> | | | | <u>Totals</u> |
|----------------|---------------------------------|----------|----------|----------|---------------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | |
| Red oak | 590 | 97 | 10 | | 697 |
| White oak | 550 | 120 | 14 | 3 | 687 |
| Chestnut oak | 13 | | | | 13 |
| Red maple | 53 | 7 | | | 60 |
| Blackgum | 180 | | | | 180 |
| Dogwood | 43 | 7 | | | 50 |
| Hickory | 90 | | | | 90 |
| Yellow-poplar | 20 | | 3 | | 23 |
| Black cherry | 10 | 3 | | | 13 |
| Sourwood | 7 | 3 | | | 10 |
| Totals | 1,556 | 237 | 27 | 3 | 1,823 |

Table 5. Average numbers of hardwoods per acre by diameter class and crown class, and basal area by crown class, at age 17.

| <u>Check Plots</u> | | | | | |
|--------------------|--------------------|---------------------|-------------------|-----------------|---------------|
| <u>DBH</u> | <u>Over-topped</u> | <u>Intermediate</u> | <u>Codominant</u> | <u>Dominant</u> | <u>Totals</u> |
| 1 | 1,527 | | | | 1,527 |
| 2 | 410 | | | | 410 |
| 3 | 70 | 30 | | | 100 |
| 4 | | 20 | | | 20 |
| 5 | | 3 | | | 3 |
| <hr/> | | | | | |
| Totals | 2,007 | 53 | | | 2,060 |
| B.A. | 20.7 | 3.6 | | | 24.3 |

| <u>1:40 Plots</u> | | | | | |
|-------------------|--------------------|---------------------|-------------------|-----------------|---------------|
| <u>DBH</u> | <u>Over-topped</u> | <u>Intermediate</u> | <u>Codominant</u> | <u>Dominant</u> | <u>Totals</u> |
| 1 | 1,717 | | | | 1,717 |
| 2 | 270 | | | | 270 |
| 3 | 23 | 3 | | | 26 |
| 4 | | 17 | | | 17 |
| 5 | | | 3 | | 3 |
| 6 | | | 3 | | 3 |
| <hr/> | | | | | |
| Totals | 2,010 | 20 | 6 | | 2,036 |
| B.A. | 16.4 | 1.6 | 1.0 | | 19.0 |

| <u>1:20 Plots</u> | | | | | |
|-------------------|--------------------|---------------------|-------------------|-----------------|---------------|
| <u>DBH</u> | <u>Over-topped</u> | <u>Intermediate</u> | <u>Codominant</u> | <u>Dominant</u> | <u>Totals</u> |
| 1 | 1,556 | | | | 1,556 |
| 2 | 237 | | | | 237 |
| 3 | 27 | | | | 27 |
| 4 | | 3 | | | 3 |
| <hr/> | | | | | |
| Totals | 1,820 | 3 | | | 1,823 |
| B.A. | 15.0 | .3 | | | 15.2 |

Table 6. Numbers of hardwoods by diameter class and crown class, and basal area by crown class, on each 1/10-acre plot.

| DBH | 0 | Check - #1 | | | Totals | | DBH | 0 | Check - #2 | | | Totals |
|--------|------|------------|----|---|--------|--|--------|------|------------|----|---|--------|
| | | I | CD | D | | | | | I | CD | D | |
| 1 | 131 | | | | 131 | | 1 | 143 | | | | 143 |
| 2 | 28 | | | | 28 | | 2 | 49 | | | | 49 |
| 3 | 8 | 5 | | | 13 | | 3 | 9 | 2 | | | 11 |
| 4 | | 3 | | | 3 | | 4 | | 1 | | | 1 |
| 5 | | 1 | | | 1 | | 5 | | | | | |
| Totals | 167 | 9 | | | 176 | | Totals | 201 | 3 | | | 204 |
| B.A. | 1.72 | .64 | | | 2.36 | | B.A. | 2.29 | .18 | | | 2.48 |

| DBH | 0 | Check - #3 | | | Totals |
|--------|------|------------|----|---|--------|
| | | I | CD | D | |
| 1 | 184 | | | | 184 |
| 2 | 46 | | | | 46 |
| 3 | 4 | 2 | | | 6 |
| 4 | | 2 | | | 2 |
| Totals | 234 | 4 | | | 238 |
| B.A. | 2.20 | .27 | | | 2.48 |

| DBH | 0 | 1:40 - #1 | | | Totals | | DBH | 0 | 1:40 - #2 | | | Totals |
|--------|------|-----------|-----|---|--------|--|--------|------|-----------|----|---|--------|
| | | I | CD | D | | | | | I | CD | D | |
| 1 | 170 | | | | 170 | | 1 | 176 | | | | 176 |
| 2 | 25 | | | | 25 | | 2 | 24 | | | | 24 |
| 3 | | | | | | | 3 | 4 | 1 | | | 5 |
| 4 | | 2 | | | 2 | | 4 | | 2 | | | 2 |
| 5 | | | 1 | | 1 | | 5 | | | | | |
| 6 | | | 1 | | 1 | | 6 | | | | | |
| Totals | 195 | 2 | 2 | | 199 | | Totals | 204 | 3 | | | 207 |
| B.A. | 1.47 | .18 | .33 | | 1.98 | | B.A. | 1.68 | .22 | | | 1.90 |

| DBH | 0 | 1:40 - #3 | | | Totals |
|--------|------|-----------|----|---|--------|
| | | I | CD | D | |
| 1 | 169 | | | | 169 |
| 2 | 32 | | | | 32 |
| 3 | 3 | | | | 3 |
| 4 | | 1 | | | 1 |
| Totals | 204 | 1 | | | 205 |
| B.A. | 1.77 | .09 | | | 1.85 |

| DBH | 0 | 1:20 - #1 | | | Totals | | DBH | 0 | 1:20 - #2 | | | Totals |
|--------|------|-----------|----|---|--------|--|--------|------|-----------|----|---|--------|
| | | I | CD | D | | | | | I | CD | D | |
| 1 | 175 | | | | 175 | | 1 | 159 | | | | 159 |
| 2 | 21 | | | | 21 | | 2 | 19 | | | | 19 |
| 3 | 4 | | | | 4 | | 3 | 1 | | | | 1 |
| 4 | | 1 | | | 1 | | | | | | | |
| Totals | 200 | 1 | | | 201 | | Totals | 179 | | | | 179 |
| B.A. | 1.61 | .09 | | | 1.70 | | B.A. | 1.33 | | | | 1.33 |

| DBH | 0 | 1:20 - #3 | | | Totals |
|--------|------|-----------|----|---|--------|
| | | I | CD | D | |
| 1 | 133 | | | | 133 |
| 2 | 31 | | | | 31 |
| 3 | 3 | | | | 3 |
| Totals | 167 | | | | 167 |
| B.A. | 1.55 | | | | 1.55 |

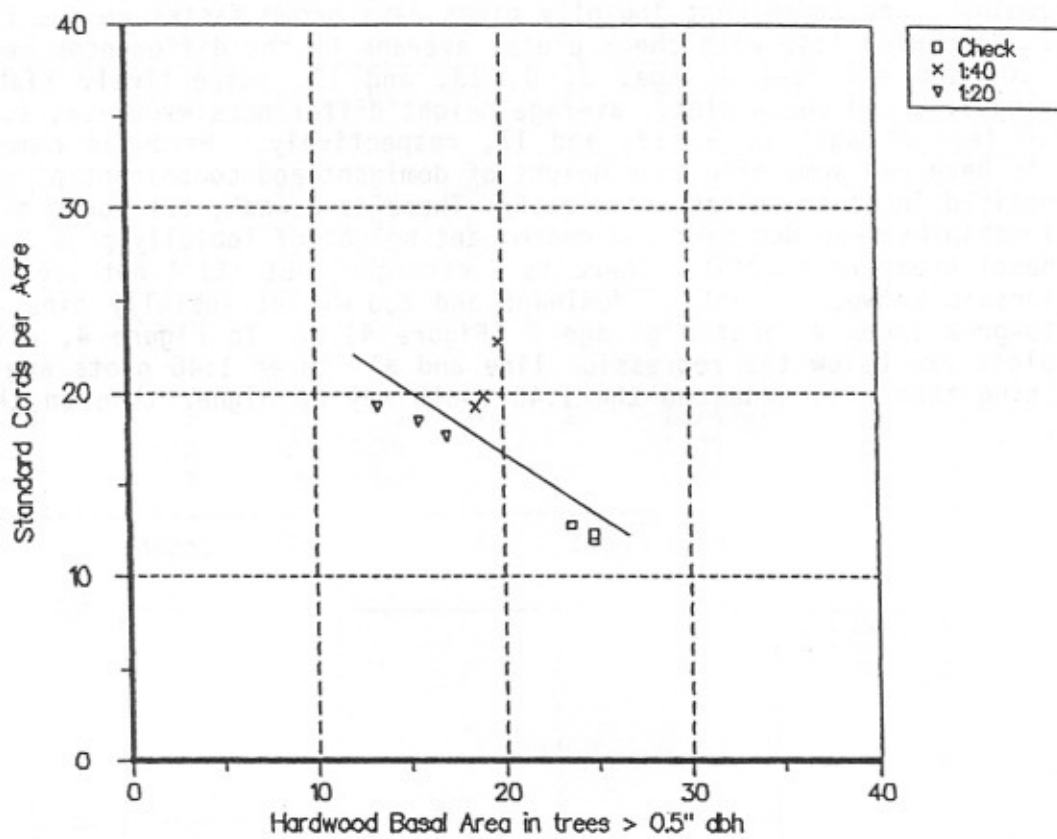


Figure 2. Pine cordwood yields at age 17 related to hardwood basal area.

Cordwood yields also correlated well with the average free-to-grow index at age 2; in fact, the correlation was better than with hardwood basal area at age 17. Table 7 shows the percent of trees in each free-to-grow class for each plot, at age 2. In Figure 3, pine cordwood yields at age 17 are plotted over average free-to-grow index at age 2 for each plot. A simple linear regression fitted to these data accounted for 67 percent of the variation in cordwood yields.^{4/}

Dominant and codominant loblolly pines have grown faster on the released plots. Comparing 1:40 with check plots, average height differences were -.1, 2.7, 4.0, and 4.4 feet at ages 2, 9, 13, and 17, respectively (Table 1). Comparing 1:20 and check plots, average height differences were -.4, 1.2, 2.0, and 2.0 feet at ages 2, 9, 13, and 17, respectively. Hardwood competition seems to have had some effect on height of dominant and codominant pine, as we have noticed in other release studies.^{5/} There is a weak, but non-significant relationship between dominant and codominant height of loblolly pine and hardwood basal area ($r^2 = .275$). There is a stronger, but still not significant, relationship between height of dominant and codominant loblolly pine and the free-to-grow index estimated at age 2 (Figure 4).^{6/} In Figure 4, all three 1:20 plots are below the regression line and all three 1:40 plots are above, suggesting that site index on the 1:40 swath may be higher than on the 1:20 swath.

4/ Estimated standard cords = $36.43 - 10.8695$ (free-to-grow index at age 2), $r^2 = .672$, probability of a larger F = .007.

5/ See Occasional Report No. 75 (Release Report No. 8) for a discussion of this relationship and its probable cause.

6/ Estimated pine height = $47.87 - 4.1895$ (free-to-grow index at age 2), $r^2 = .352$, probability of a larger F = .092.

Table 7. Percent of trees by free-to-grow class for each plot, at age 2.

| | | Free-to-grow Status | | | | |
|-------|-------|---------------------|----|----|---|-------|
| | Plot | 1 | 2 | 3 | 4 | Means |
| Check | 1 | 7 | 64 | 22 | 7 | 2.29 |
| | 2 | 17 | 58 | 23 | 2 | 2.09 |
| | 3 | 22 | 61 | 14 | 2 | 1.96 |
| | Means | 15 | 61 | 20 | 4 | 2.11 |
| 1:40 | 1 | 49 | 43 | 8 | | 1.59 |
| | 2 | 38 | 57 | 6 | | 1.68 |
| | 3 | 30 | 68 | 2 | | 1.73 |
| | Means | 39 | 56 | 5 | | 1.67 |
| 1:20 | 1 | 39 | 51 | 9 | 2 | 1.74 |
| | 2 | 65 | 35 | | | 1.35 |
| | 3 | 45 | 53 | 2 | | 1.56 |
| | Means | 50 | 46 | 4 | 1 | 1.55 |

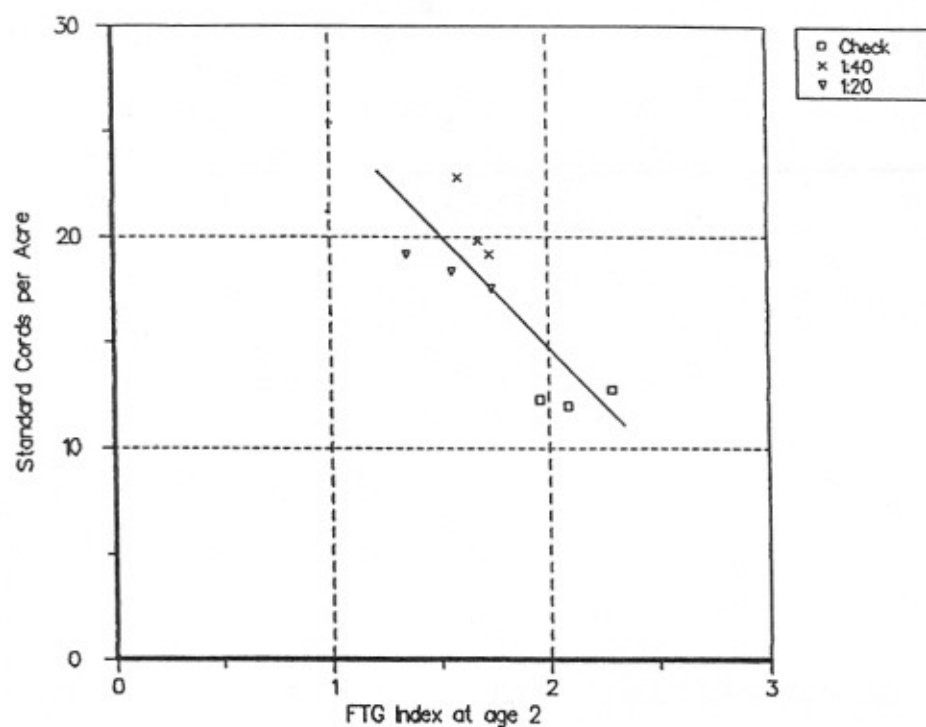


Figure 3. Pine cordwood yields at age 17 related to FTG index.

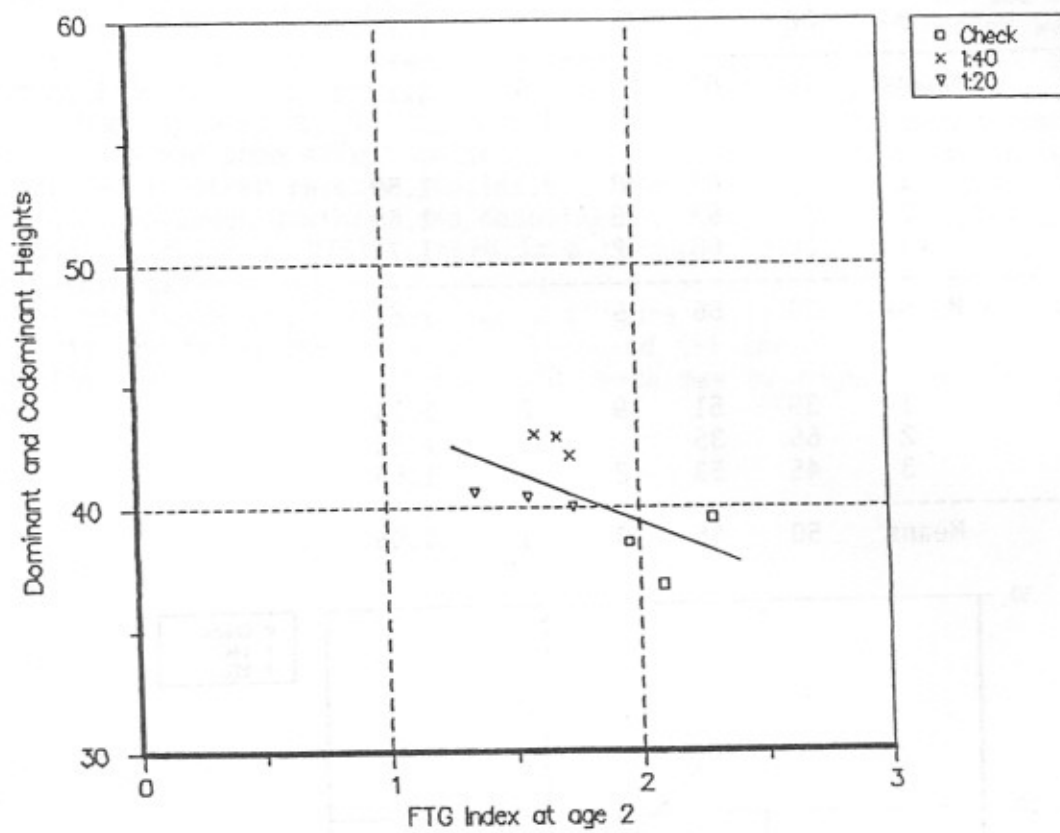


Figure 4. Pine dominant and codominant height at age 17 related to FTG index.